RICE UNIVERSITY

Dynamic Densities

by

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A THESIS SUBMITTED
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE

Master of Architecture

APPROVED, THESIS COMMITTEE

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HOUSTON, TEXAS
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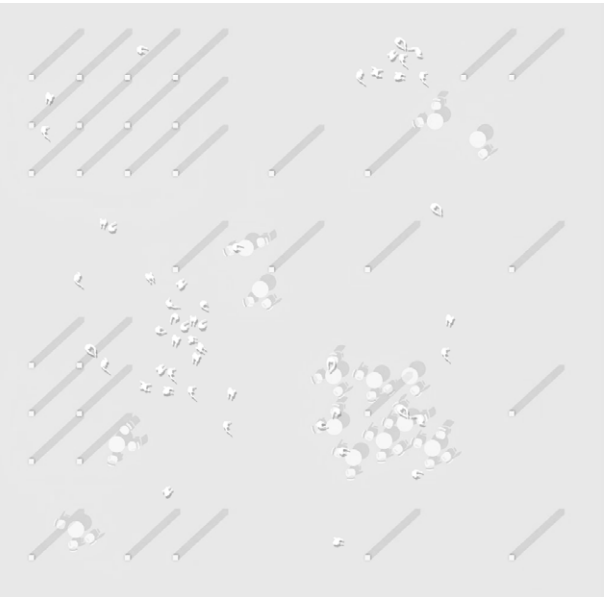
DYNAMIC DENSITIES

Mengxiao Qi



[Figure 1]
Different densities of columns and furniture will result in different distributions of occupants

ABSTRACT

DYNAMIC DENSITIES

This thesis uses density as a tool to diversify generic space and thus influence human behavior.

The density of a space dictates the amount of visual information that one can receive in a room. It can be categorized into four layers based on their contributions to spatial formation: structures, openings, materials and furniture. The overlapping among four layers helps reach optimum visual diversity that accommodates to various needs.

The project, Rice Student Center, engages a program that embraces complexity and yearns for extra diversity. The methodology of dynamic densities is used to generate diversified visual effects in different architectural environments and to celebrate the discontinuous, oscillating and unstable spatial experience that follows.

ACKNOWLEDGMENT

THANKS TO

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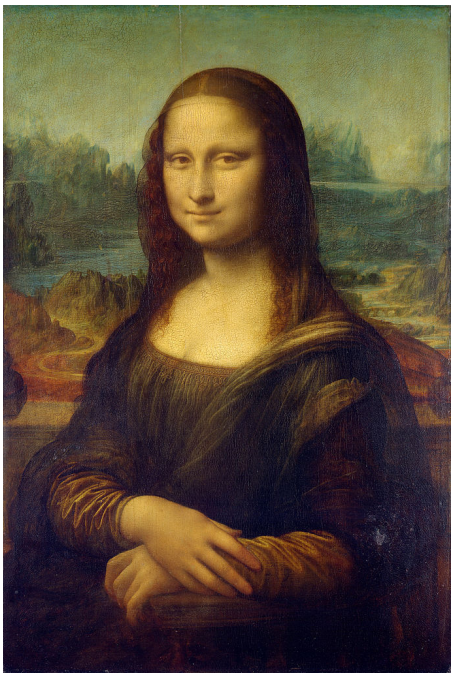
MY FAMILY for their unconditional support.

TABLE OF CONTENTS



[Figure 2]
The enigmatic "now you see it, now you don't" effect of the Mona Lisa smile is the outcome of the reprocessing of human brains

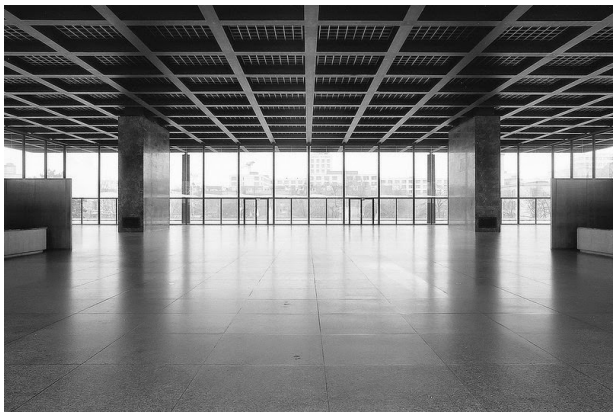
DENSITY:

MANIPULATION OF VISUAL INFORMATION

We live in a visual world and people comprehend the world differently. We envision the reality through the information captured by our eyes and reprocess it in our brain. A system that regulates the visual information of architecture is crucial to better spatial quality and higher occupant engagement.

Density, as it describes the number and distribution of the objects in a space, works as a perfect tool to add on or filter out the desirable visual information in need. By manipulating the density of a space, distinct visual effects that appeal to different observers could be generated and maximum diversity is thus produced.

[Figure 3]
Kanagawa Institute of Technology KAIT Workshop by Junya Ishigami



[Figure 4]
New National Gallery in Berlin by Mies van der Rohe

PRECEDENTS:

THE COMPLEXITY OF DENSITY

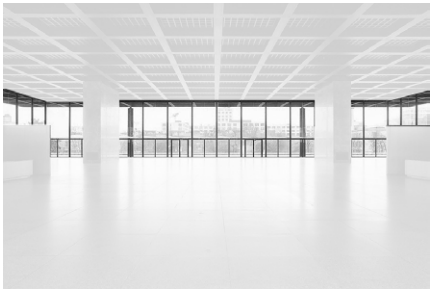
Junya Ishigami's KAIT Workshop and Mies Van der Rohe's New National Gallery were designed with opposing architectural ideologies that produced two distinctive experiences for the observers: the dense elaborate detailing of Ishigami and vast disclosure of Mies.

Although the density difference between the two buildings is quite obvious at first glance, the closer examination of individual architectural elements will result in completely different conclusions (see in Figure 5-12).

[Figure 5]
Columns in KAIT workshop is very dense.

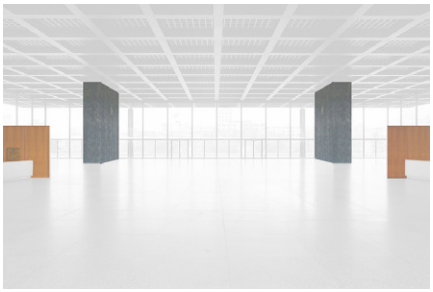
[Figure 6]
There is no column in the New National Gallery.

[Figure 7]
KAIT workshop is open on four sides.



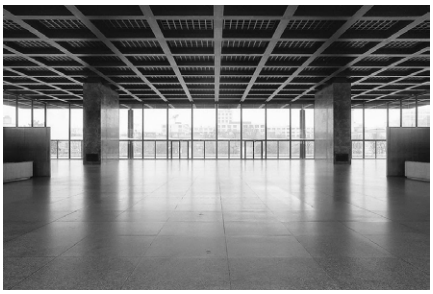
[Figure 8]
The New National Gallery is open on four sides.

[Figure 9]
Materials in KAIT workshop are all white.



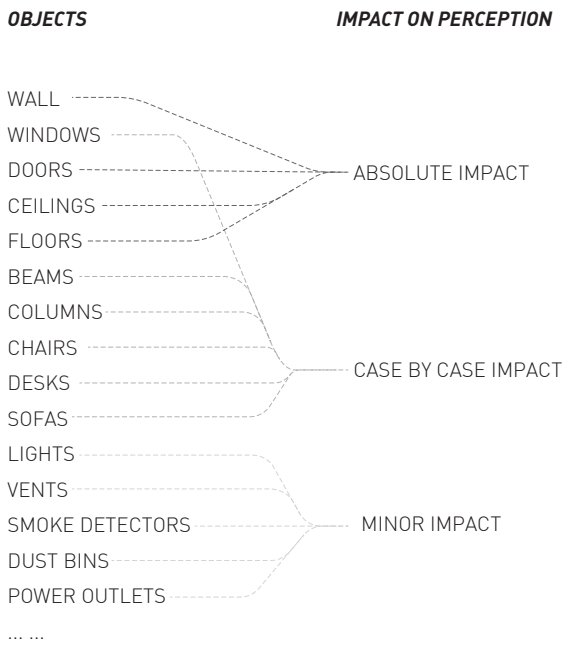
[Figure 9]
Multiple materials with details are used in the New National Gallery.

[Figure 10]
Furniture in KAIT workshop is arranged randomly.



[Figure 11]
Furniture in the New National gallery museum is center focused.

[Figure 5-11]
Observers will have opposite conclusions of densities when comparing the different aspects of the two buildings.



[Figure 12]
Objects have different impact on visual perception

METHODS:

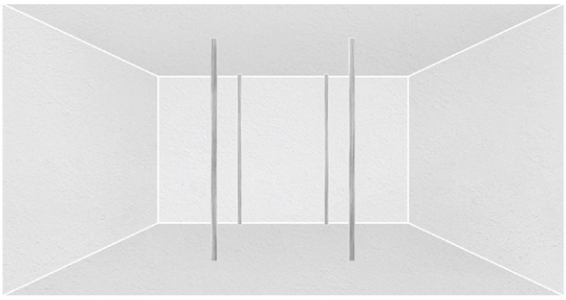
DENSITY LAYERS

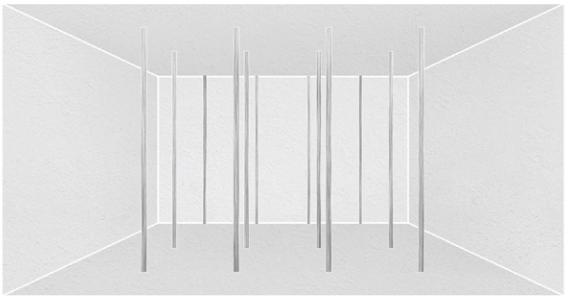
A wide range of objects could be seen in a space: walls, windows, doors, ceilings, beams, columns, chairs, desks, sofas, lights, vents, smoke detectors, dust bins, and power outlets. Excessive numbers of objects in a space will require a more inquisitive procedure in order to manipulate the density of a space containing an overwhelming amount of factors.

On one hand, different objects contribute to spatial composition distinctively and thus have various levels of impact on the observer's perception. Objects like walls, ceilings and floors works in an absolute way as they frame observers' views. Objects such as chairs, desks, lamps or umbrella racks affect people's perception in a subtle and case by case way.

On the other hand, although our eyes deliver the same amount of information, people have different sensitivity to the same object. For example, some people focus on furniture arrangement whereas others may be more sensitive to material selection.

As a result, it is necessary to subdivide the overall density into several layers that contain similar architectural components. Therefore, the complexity of manipulating too much visual factors at the same time is largely reduced.



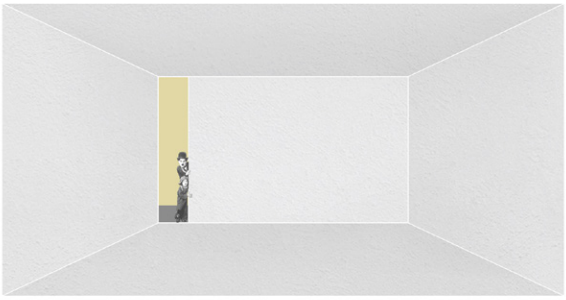


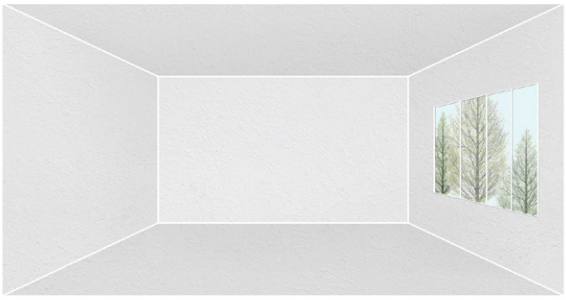
[Figure 13-15]
Open / Medium / Dense structures

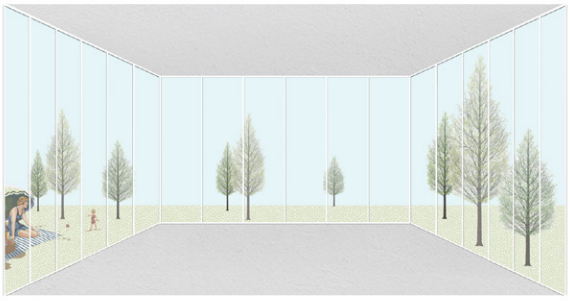
LAYER OF DENSITY:

STRUCTURES

The density of structures dictates the number of columns and beams that the observers could physically see in a room.







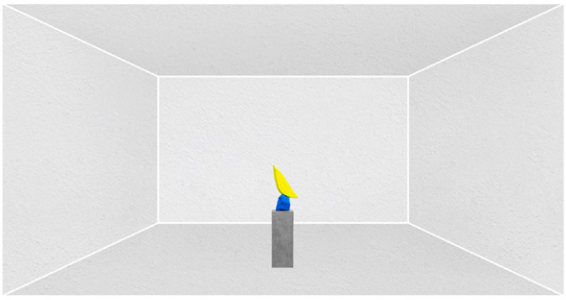
[Figure 16-18]
Minor / Medium / Dense openings

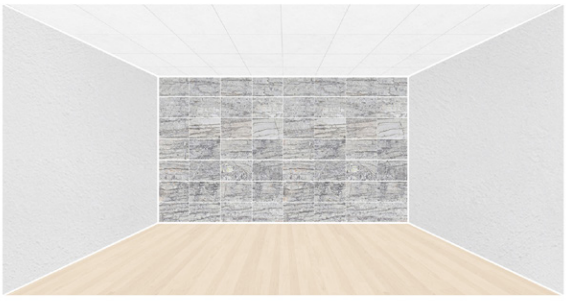
LAYER OF DENSITY:

OPENINGS

The density of openings within a space frames observers' visions and manage their access to exterior information.

Minor openings funnel limited information from the outside environment and triggers the observer's curiosity. Transparency resulting from maximum openness gives away all information and blurs the boundary between interior and exterior.





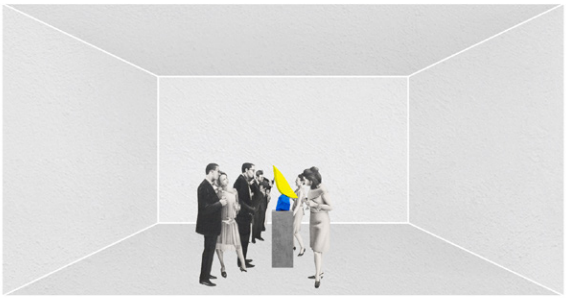
[Figure 19-21]
Silent / Medium / Intense materials

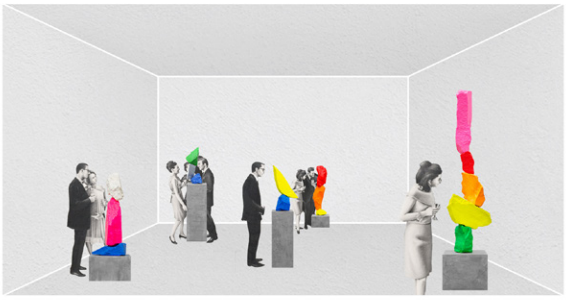
LAYER OF DENSITY:

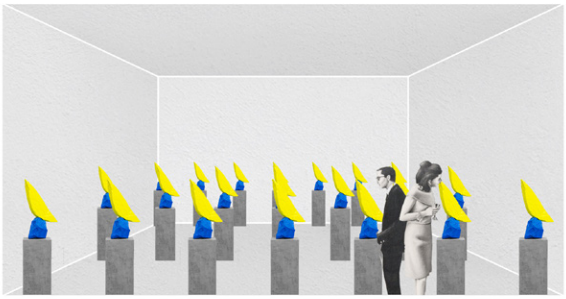
MATERIALS

The density of materials can be understood as the intensity of materials that observers could perceive.

Intense materials such as marble and mosaic contain abundant details that attract observers' attention. They manifest the architectural elements themselves. Silent materials have minimum details and make the architectural elements disappear in order for the programmatic content to stand out.





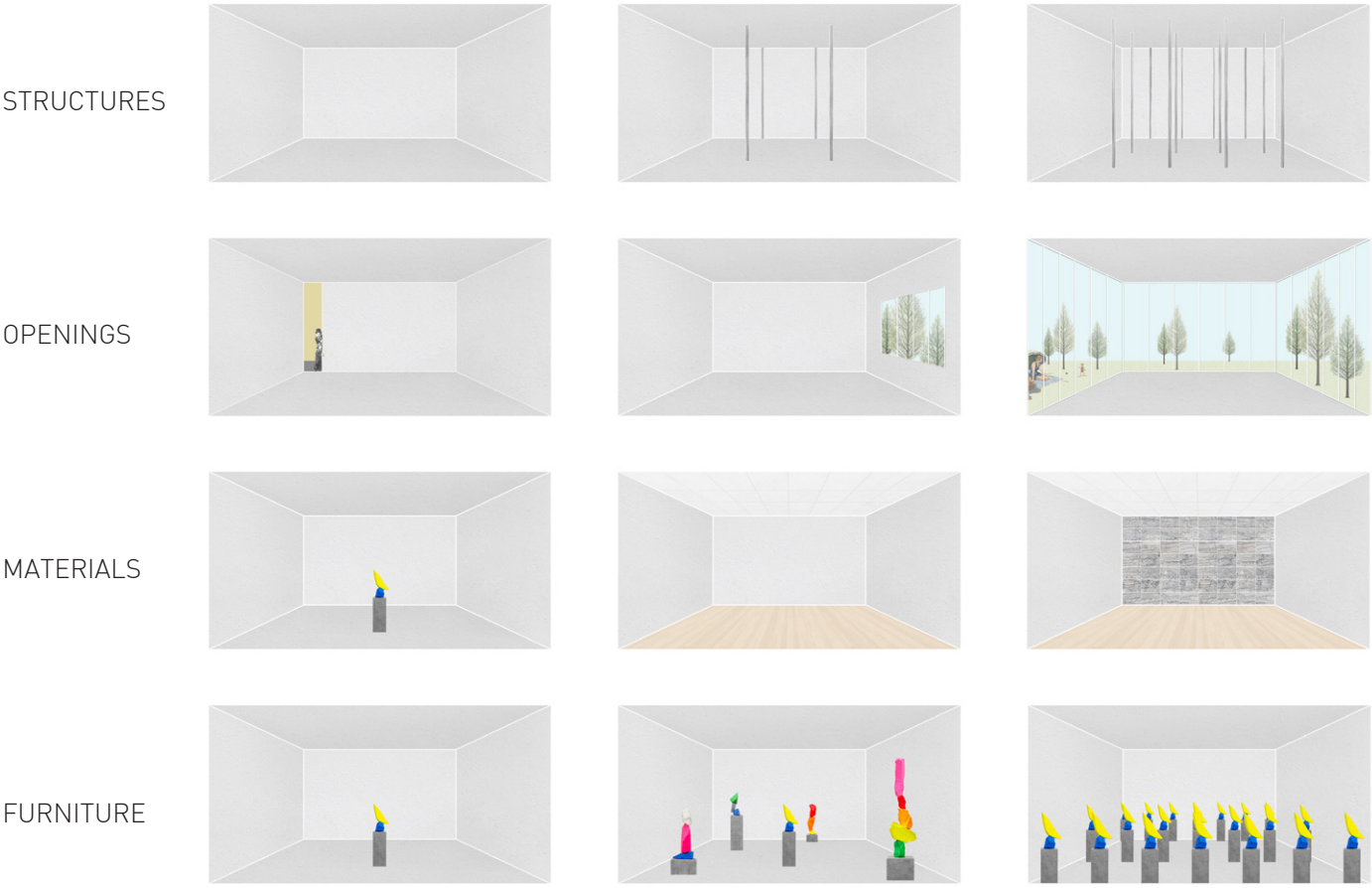


[Figure 22-24]
Center-focused / Medium / Dense furniture

LAYER OF DENSITY:

FURNITURE

The density of furniture dictates the number of furniture and their arrangement. It influences the distribution of occupants and their circulation directly.

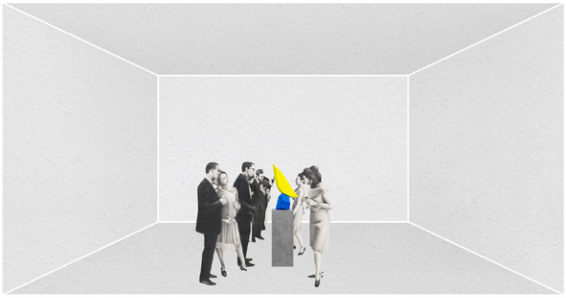


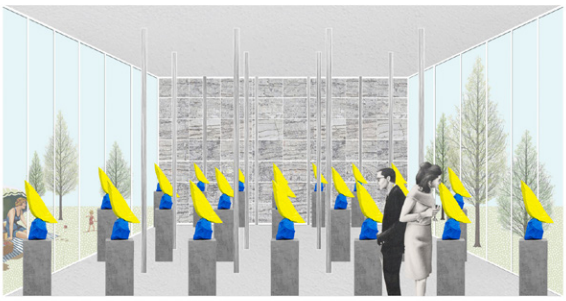
[Figure 25]
Comparison among four layers

FOUR LAYERS:

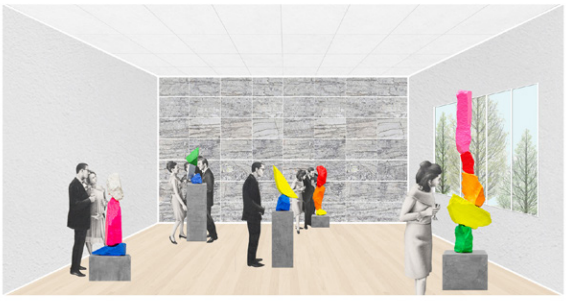
STRUCTURES, OPENINGS, MATERIALS AND FURNITURE

The four layers of densities, structure, openings, materials and furniture, represent the four types of architectural elements that hold the most impact on visual perceptions. The layers of structures, openings and furniture set up the primary density of a space as they dictate the number of visual elements. The layer of materials adjusts the primary density through adding or reducing details to the previous layers. The four layers work together to form an integrated space.





[Figure 26-27]
The dramatic difference between rooms



[Figure 28-29]
The nuance between rooms

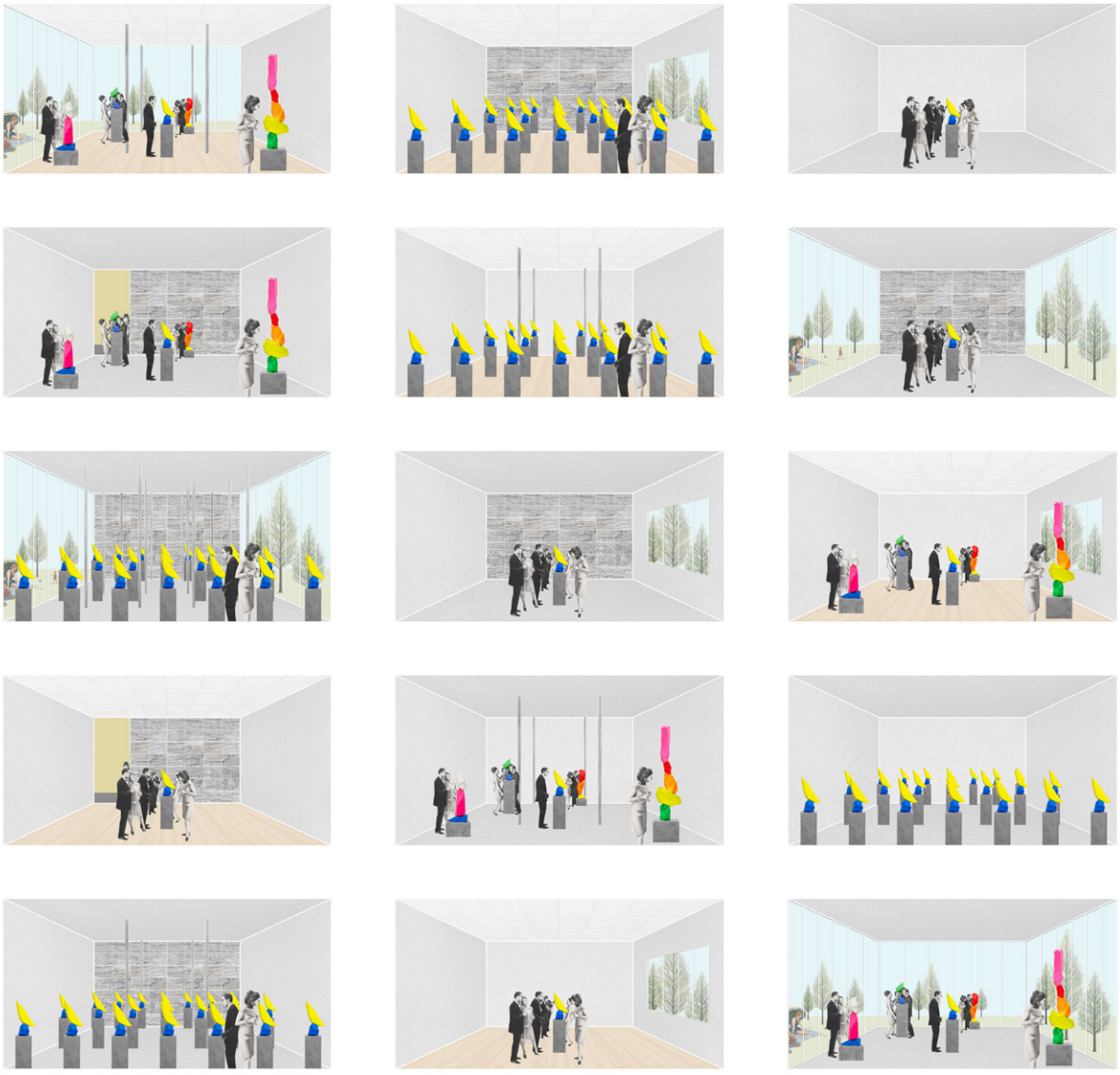
COMPOSITE DENSITY:

THE AMALGAMATION OF LAYERS

The density of overlapping layers is not a simple addition of four layers but a multiplication of them. The complexity of composite density lies in the interplay among the individual layers.

The four layers could agree with each other to make the composite density to an extreme. Therefore, the overall difference between two rooms could be dramatic, as shown in figure 27 (the amalgamation of no structure or opening, least materials and furniture) and figure 28 (the amalgamation of dense structures, mass openings, intense materials and dense furniture). Or the four layers can work against each other to create nuance. As showed in figure 29 (the amalgamation of dense structures, no opening, intense materials and least furniture) and figure 30 (the amalgamation of no structure, medium openings, intense materials and medium furniture).

As a result, the composite density has greater spectrum of diversity than any singular layer and is able to provide any possible density according to the occupants' needs.



[Figure 30]
Examples of composite densities

[Site Plan]
Simplified map of Houston

SITE:

RICE UNIVERSITY

Rice University is chosen as the site to test out the methodology of dynamic densities.

The Rice campus is the sea of multiple facilities that seeks individuality as well as unity. Its residents come from different races, ethnicities, religious beliefs, generations and economic backgrounds. The essential diversity of Rice university's composition requires comparable diversity in its architectural form.

[Site Plan]
Site plan of Rice University

[Site Plan]
Zoom site plan

exhibition 8500 sf	exhibition 1	2500
	exhibition 2	2500
	exhibition 3	2500
	storage	1000
library 12000 sf	media center	1000
	magazine	2000
	library	2000
	computer lab	500
	printing room	500
	study room 1	3000
	study room 2	3000
gym 8000 sf	badminton court and gym	5500
	audience area	1000
	changing room	1500
auditorium 9500 sf	auditorium	5000
	stage	2000
	back stage and auxiliary	1000
	rehersal	1500
dining 7500 sf	multi-function dining hall	3500
	regular dining	2500
	kitchen	1500
others 15000 sf	courtyard	5000
	lounge	5000
	mechanics and bathrooms	5000
total		61500

[Program Diagram]
Program distribution sheet

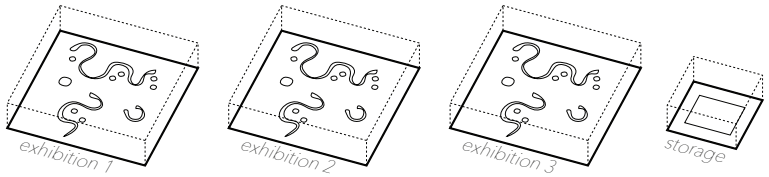
PROGRAM:

STUDENT CENTER

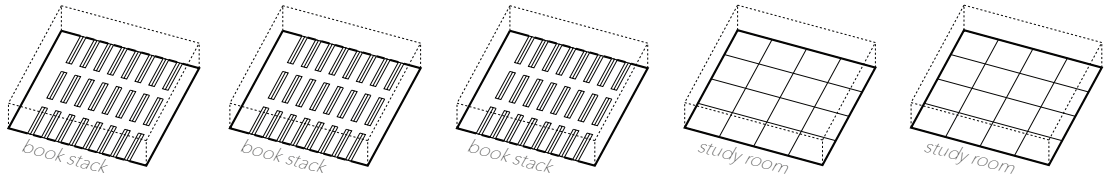
A student center containing an auditorium, gym, library, exhibition and dining area is conceived as a condensed and miniature community and is put on the campus.

As a multifunctional building, the setting of Rice Student Center has the capacity to embrace the diversity of architectural density as well as population.

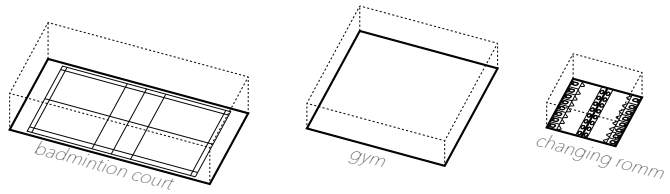
EXHIBITION
8500 sf



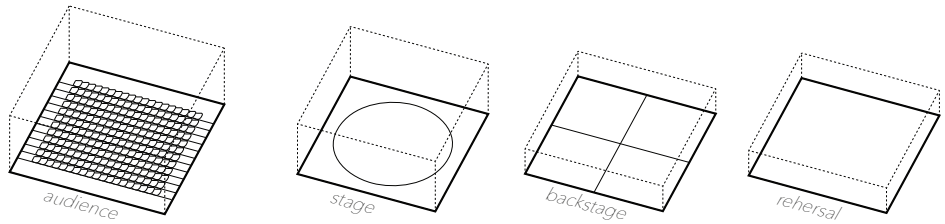
LIBRARY
12000 sf



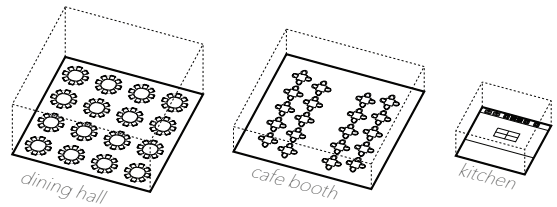
GYM
8000 sf



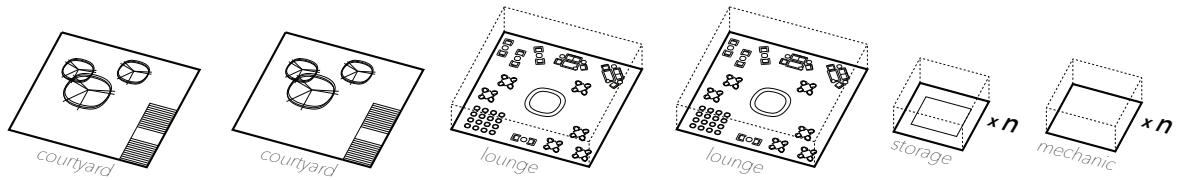
AUDITORIUM
9500 sf



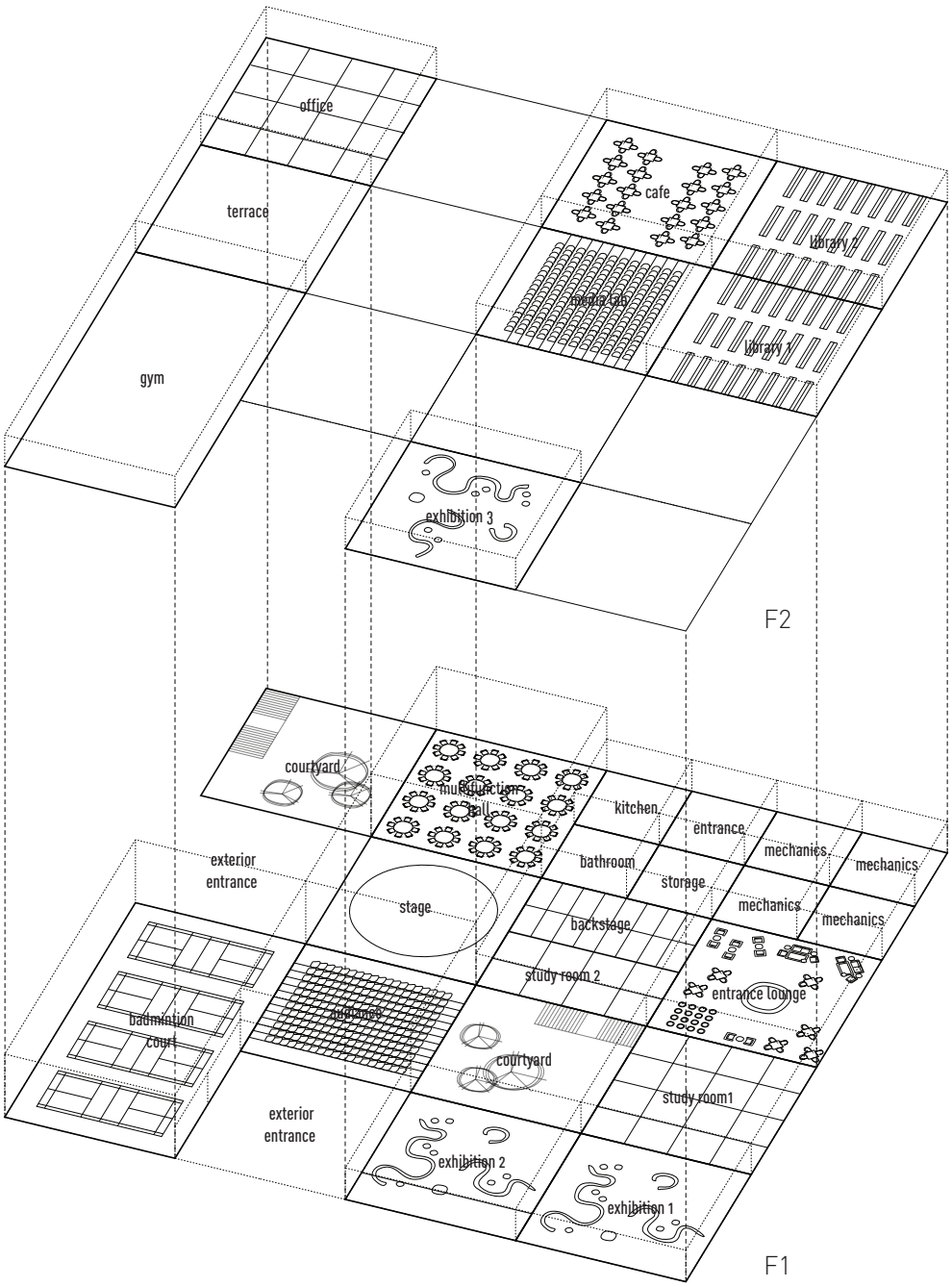
DINING
7500 sf



OTHERS
15000 sf



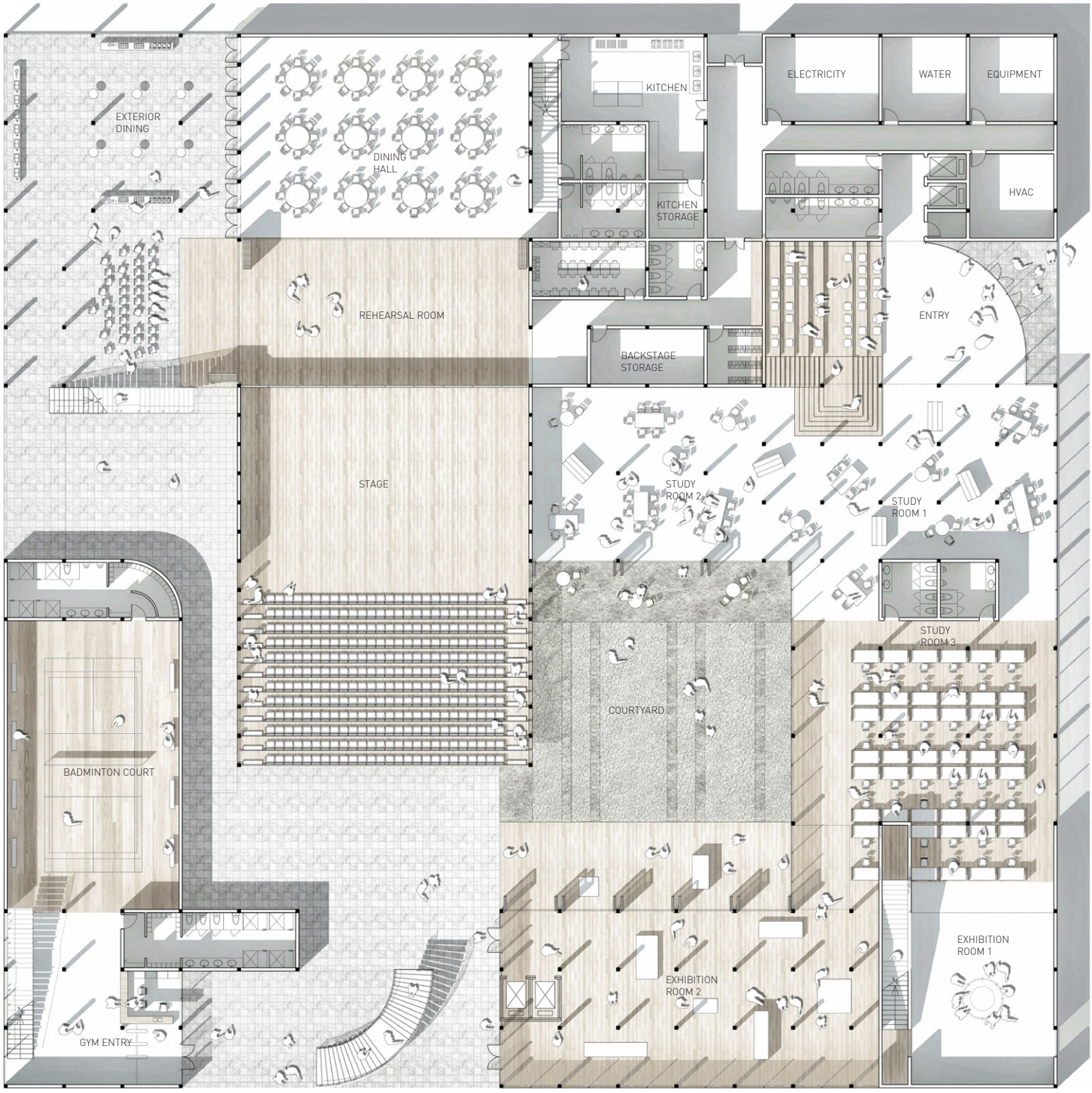
[Program Diagram]
Abstract visualization of program size



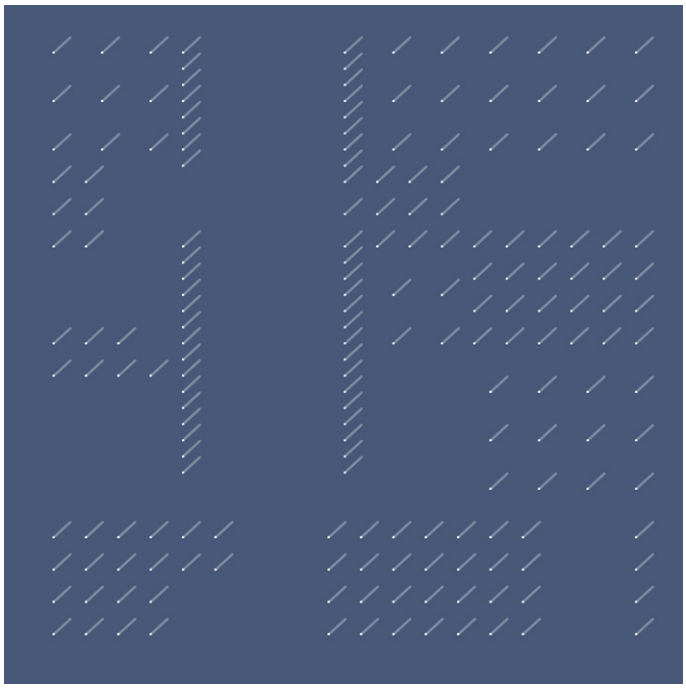
[Program Diagram]
Abstract visualization of program distribution in plan

[Site Plan]

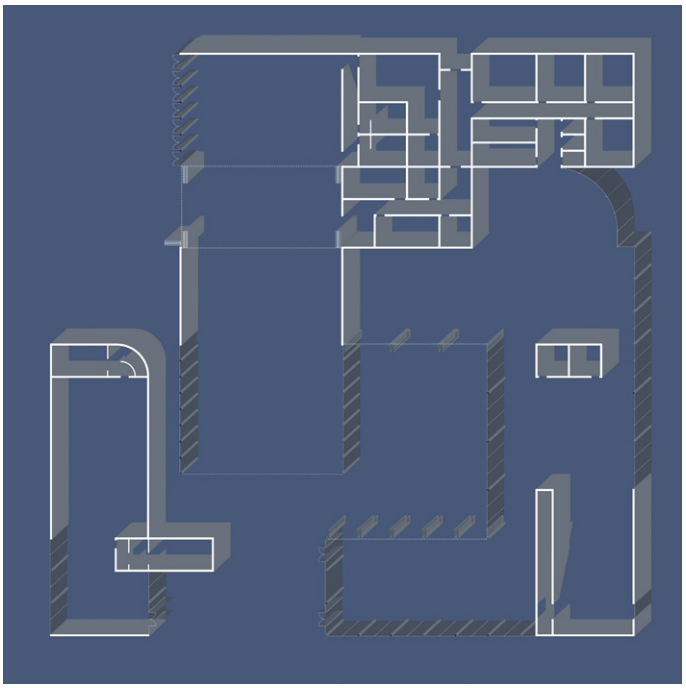
Although the methodology of dynamic densities mainly focuses on the internal of the Rice Student Center, it does have the capability to change the density of the building's periphery. Different positions of the Rice student center allow the building itself to work as a component to reshape the density of the campus.


EXTERIOR DINING
DINING HALL
KITCHEN
ELECTRICITY
WATER
EQUIPMENT
KITCHEN STORAGE
HVAC
REHEARSAL ROOM
ENTRY
BACKSTAGE STORAGE
STAGE
STUDY ROOM 2
STUDY ROOM 1
STUDY ROOM 3
COURTYARD
BADMINTON COURT
EXHIBITION ROOM 1
EXHIBITION ROOM 2
GYM ENTRY

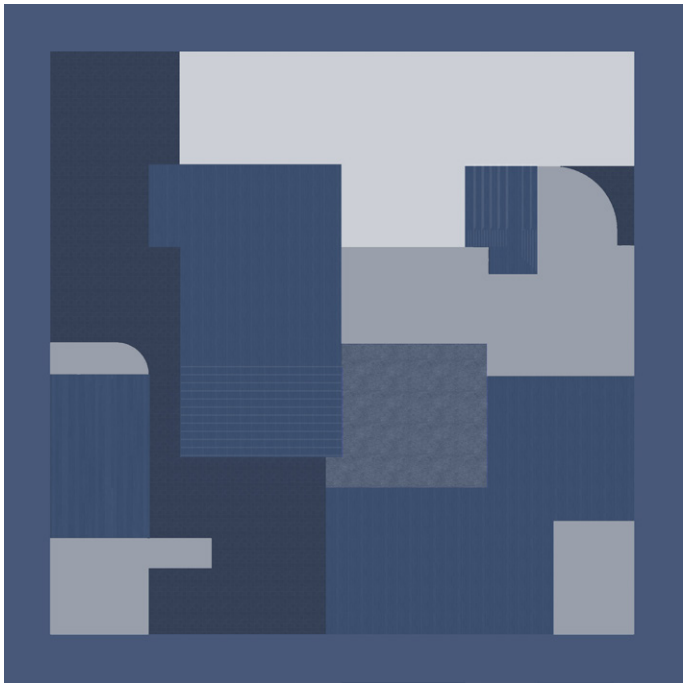
[Plan F1]



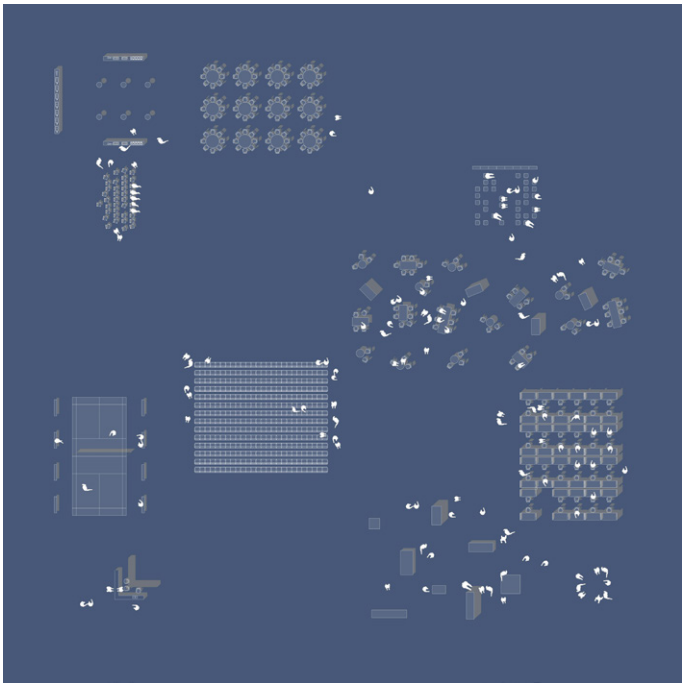
[Diagram 1]
Density of structures, F1



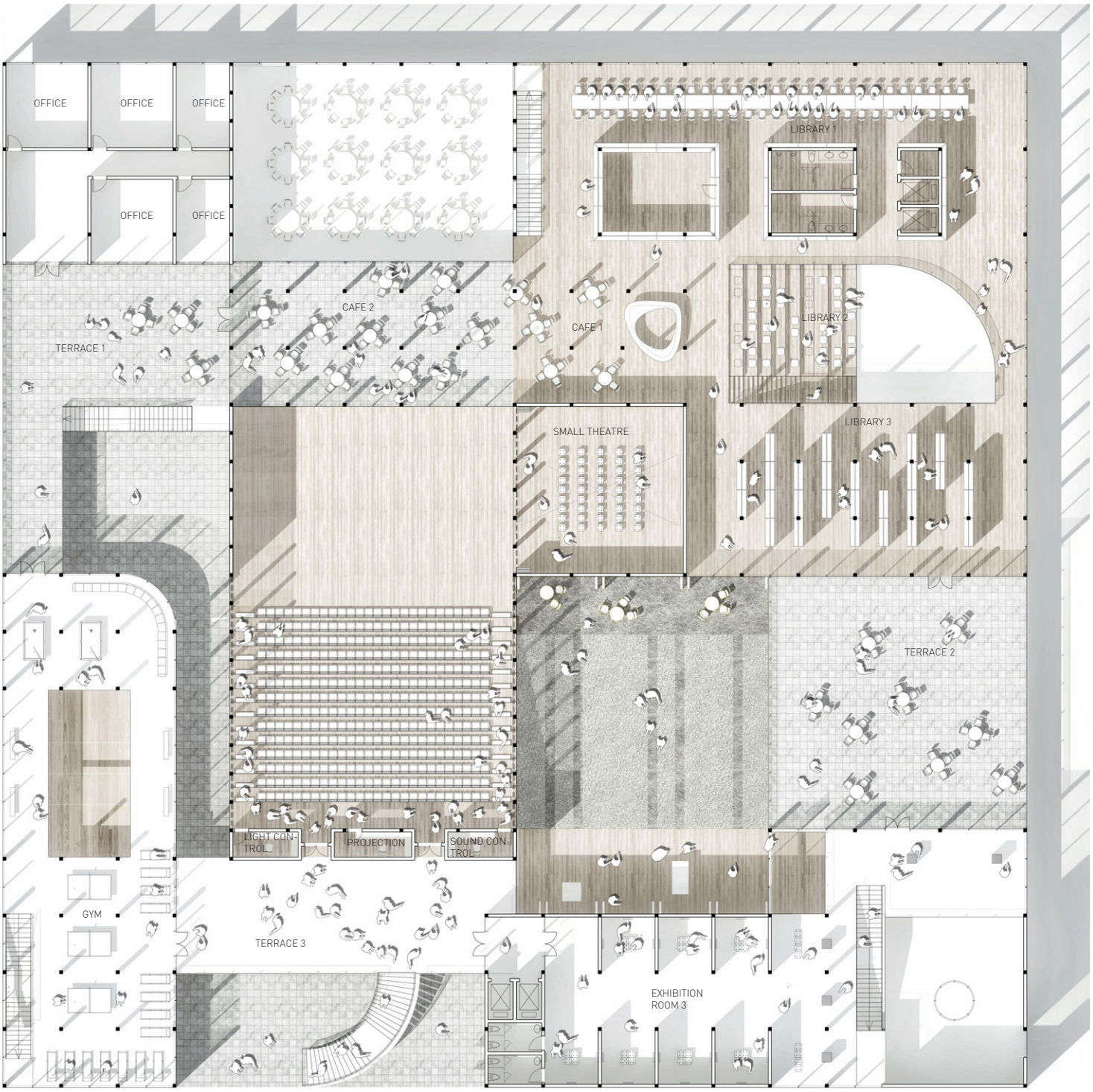
[Diagram 2]
Density of openings, F1



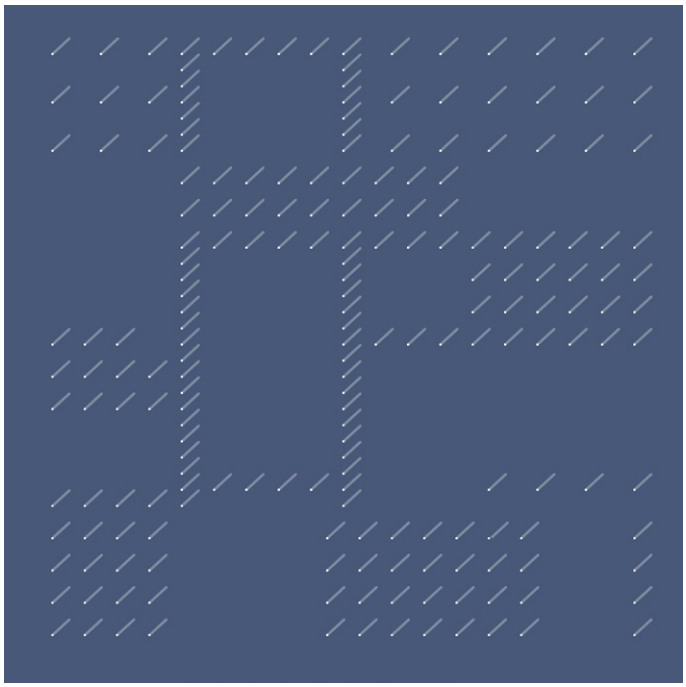
[Diagram 3]
Density of materials, F1



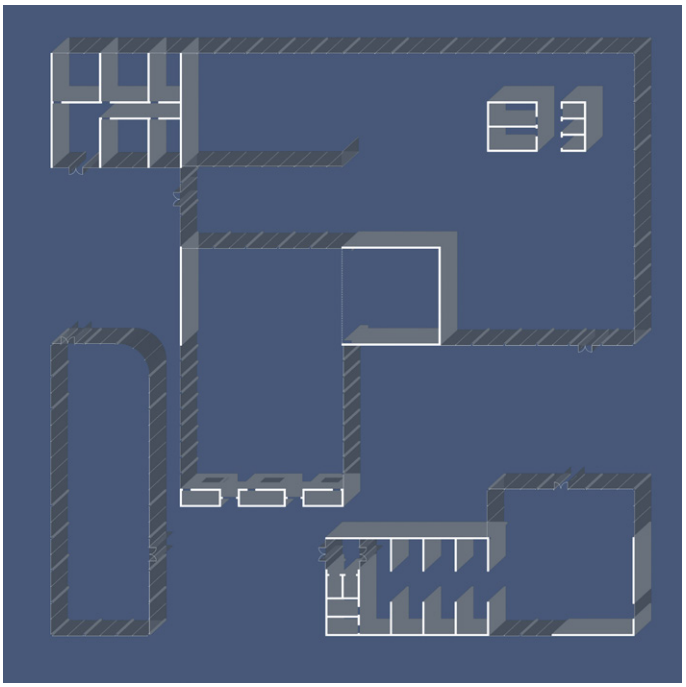
[Diagram 4]
Density of furniture, F1


OFFICE
OFFICE
OFFICE
OFFICE
OFFICE
LIBRARY 1
CAFE 2
CAFE 1
LIBRARY 2
TERRACE 1
SMALL THEATRE
LIBRARY 3
TERRACE 2
LIGHT CON-
TROL
PROJECTION
SOUND CON-
TROL
GYM
TERRACE 3
EXHIBITION
ROOM 3

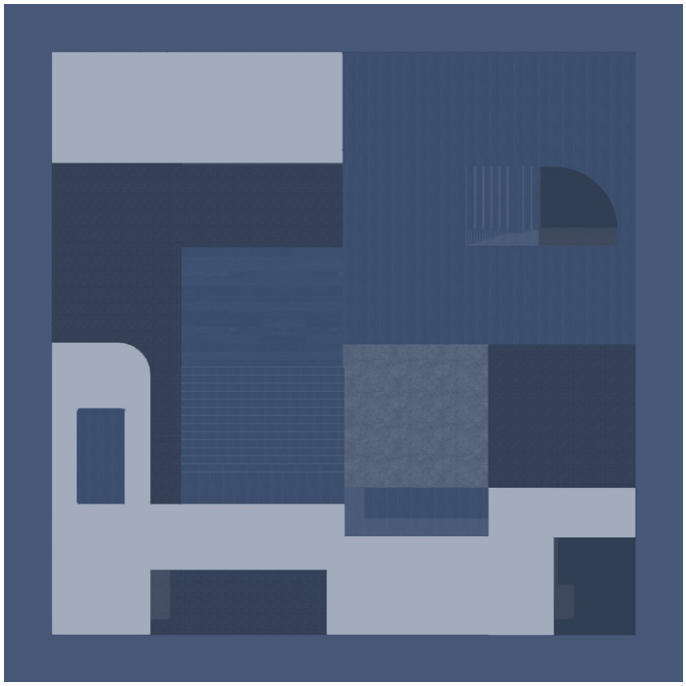
[Plan F2]



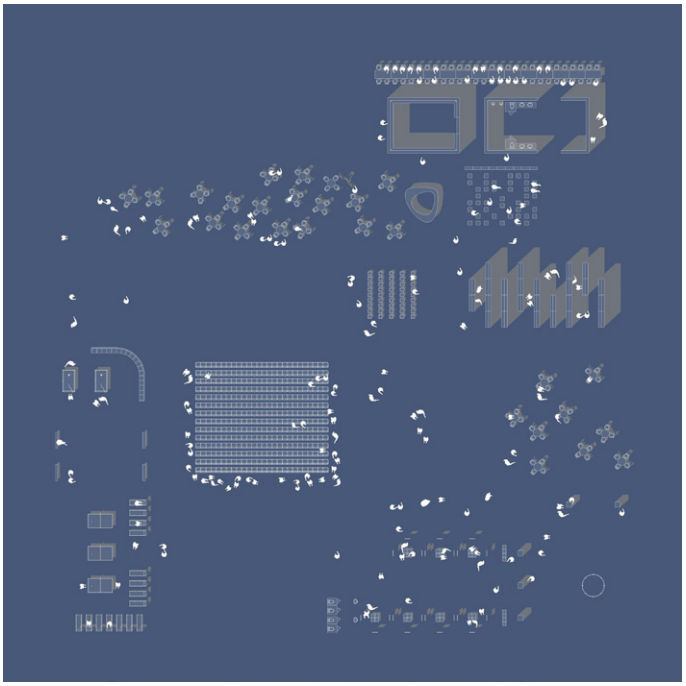
[Diagram 5]
Density of structures, F2



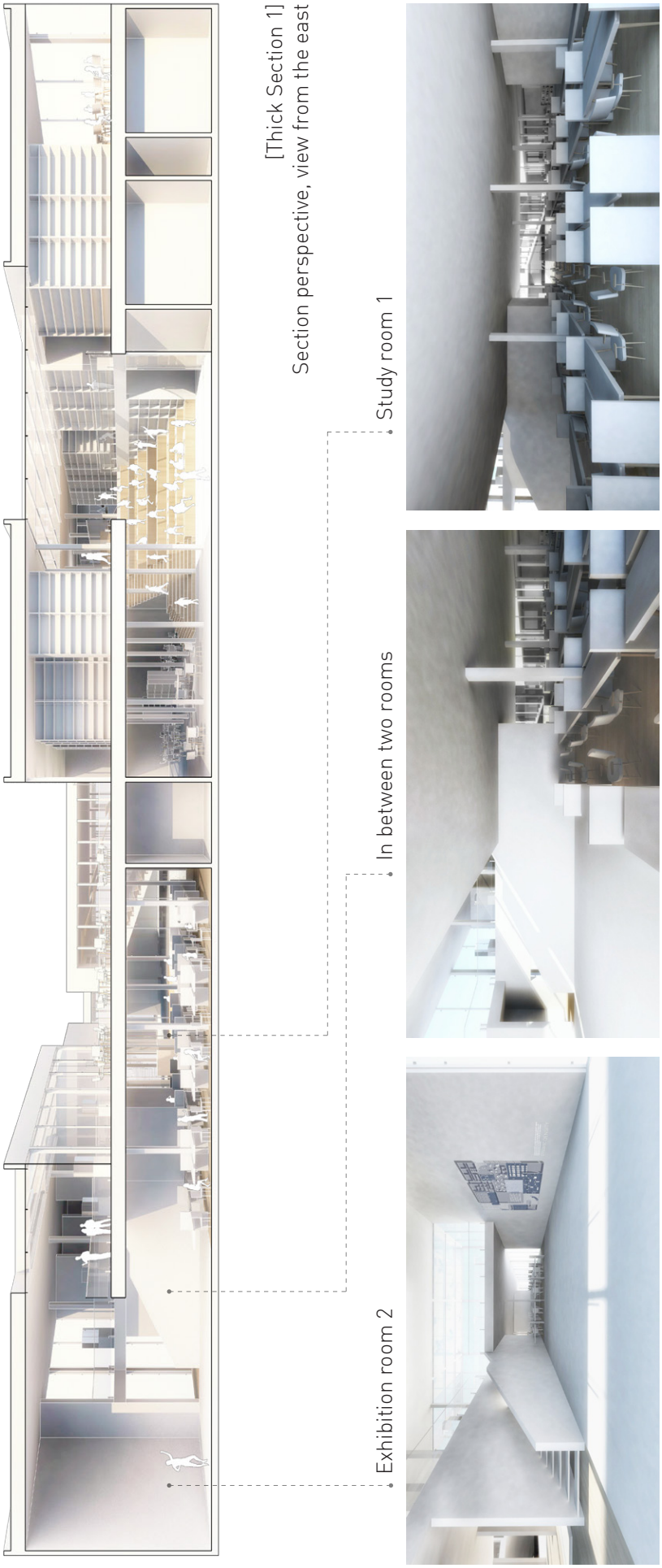
[Diagram 6]
Density of openings, F2



[Diagram 7]
Density of materials, F2



[Diagram 8]
Density of furniture, F2



[Thick Section 1]
Section perspective, view from the east

Study room 1

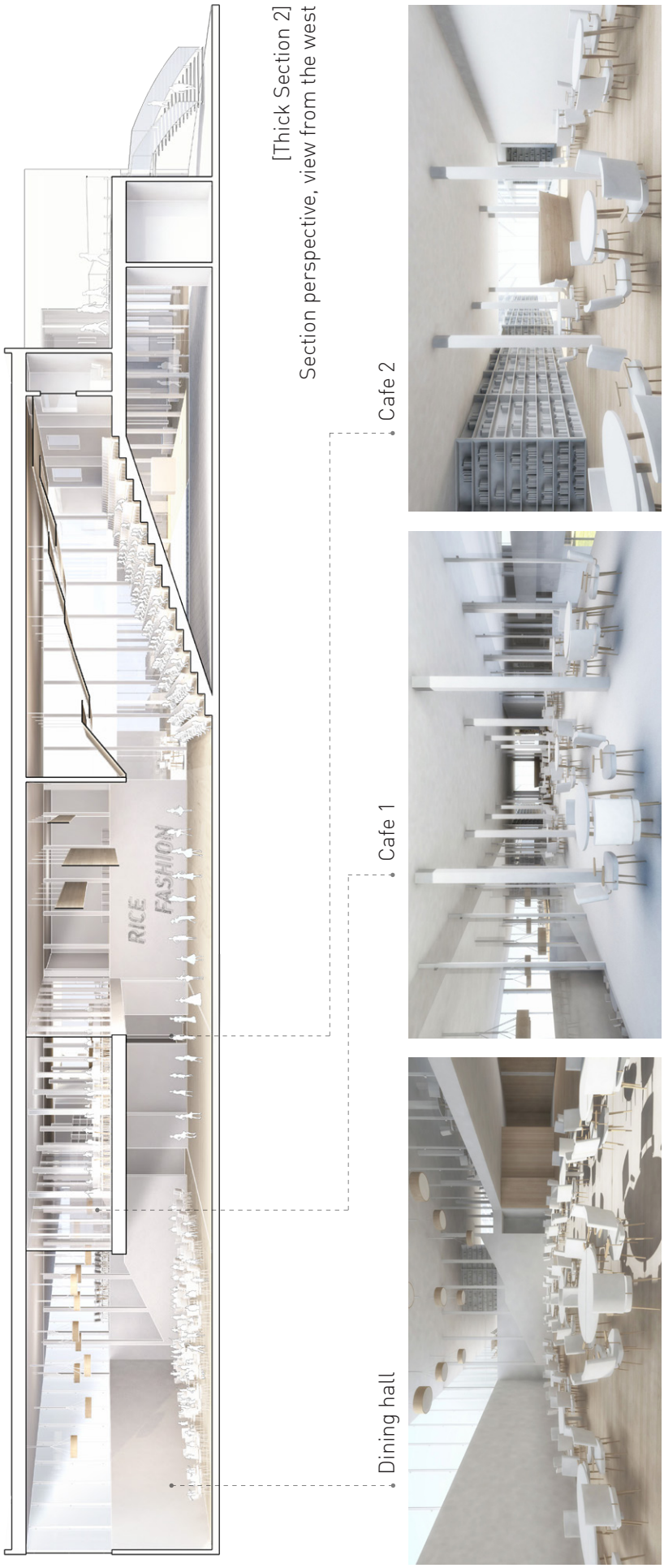
In between two rooms

Exhibition room 2

CONTRASTING TRANSITION:

DISCONTINUOUS SPATIAL EXPERIENCE

By overlapping four similar layers that agree with each other, the densities of the exhibition room (bottom) and study room (top) reach two extremes: extra open and extra dense. The adjacency of two extreme rooms produces a dramatic contrast that marks the transition to different programs.



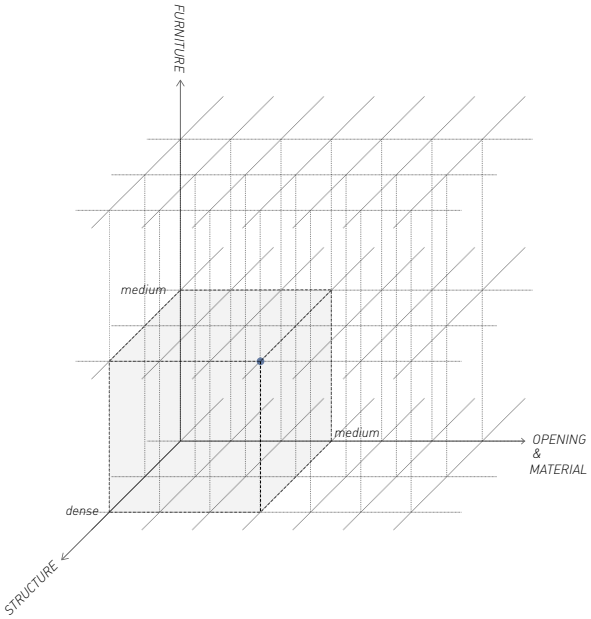
[Thick Section 2]
Section perspective, view from the west

NUANCED TRANSITION:

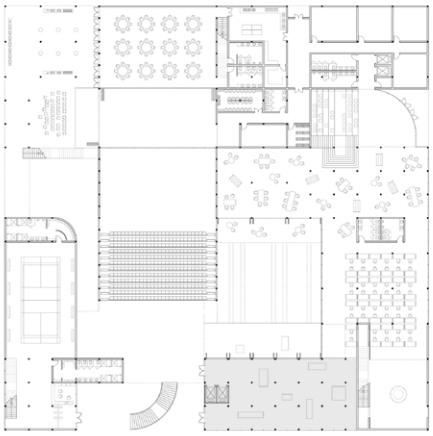
CONTINUOUS SPATIAL EXPERIENCE

By overlapping four contrasting layers that work against each other, the density contrast between the dining hall (bottom) and the cafe area (middle and top) is reduced. The adjacency of two "nuanced rooms" produces a subtle change and smooth transition between rooms that marks the transition within the same program.

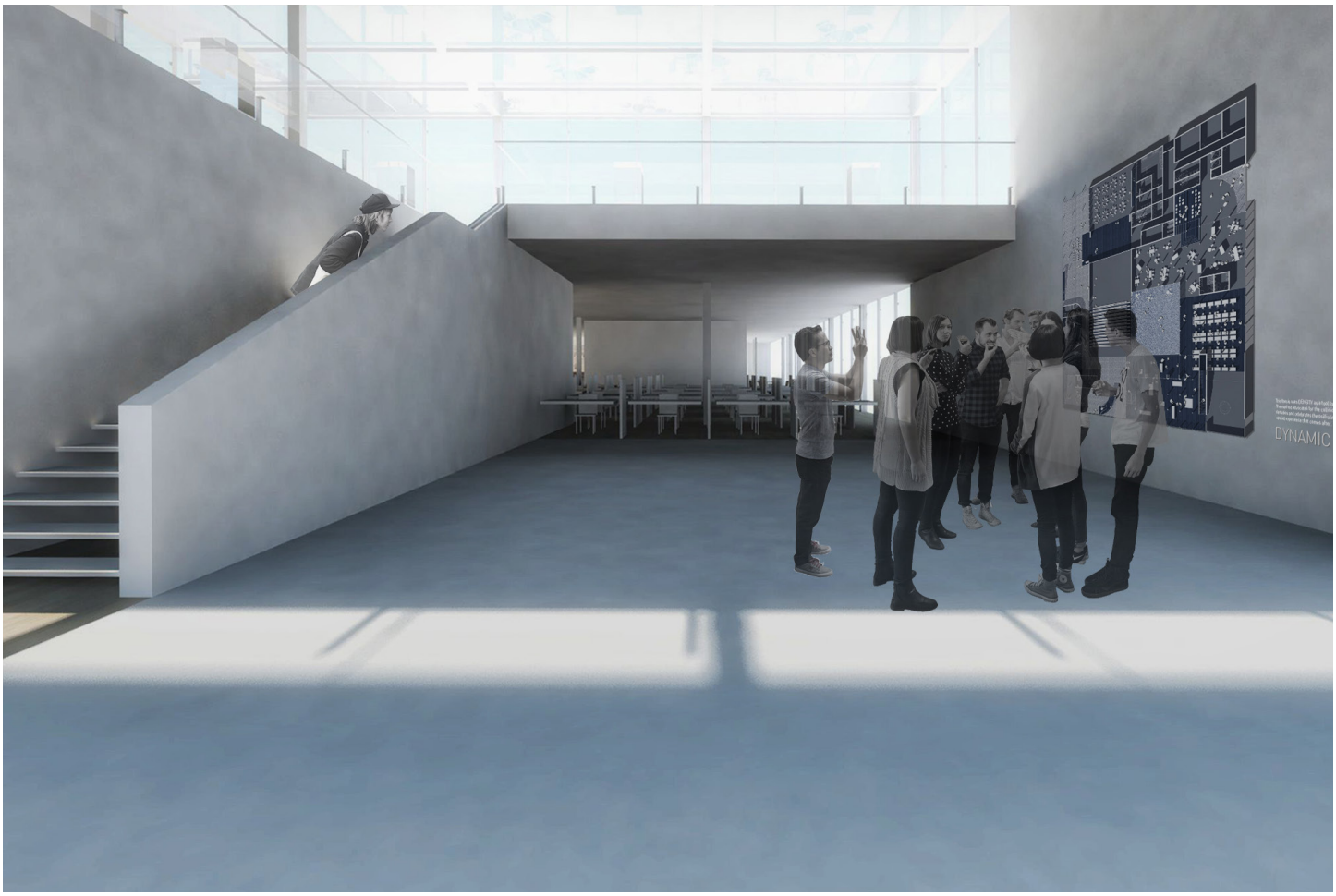
[Rendering 1]
Exhibition room 1



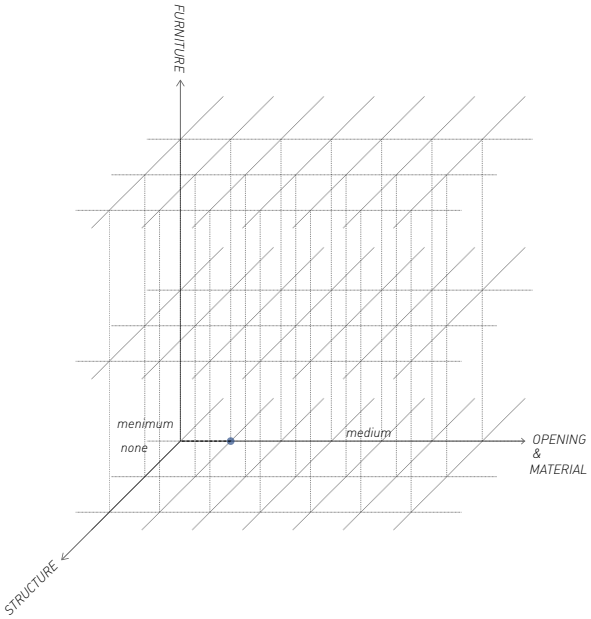
[Density Diagram]
Exhibition room 1



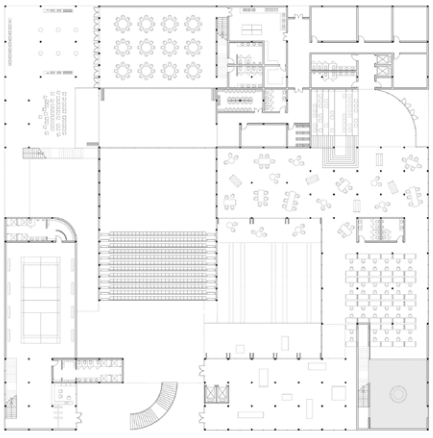
[Key Plan]
Exhibition room 1



[Rendering 2]
Exhibition room 2

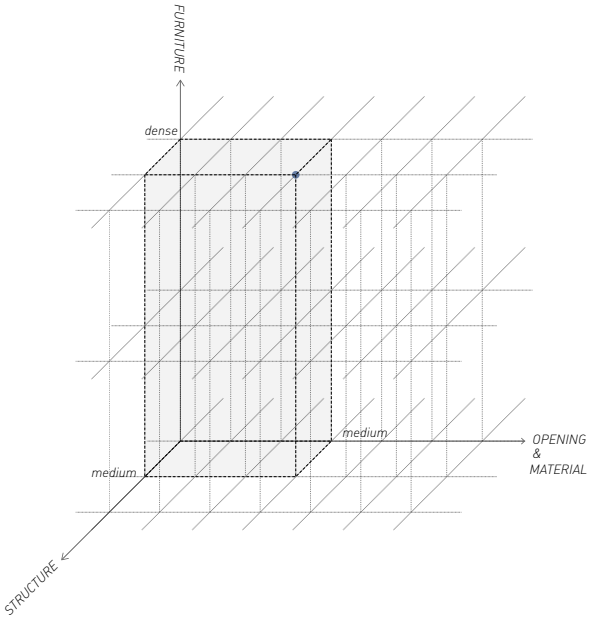


[Density Diagram]
Exhibition room 2

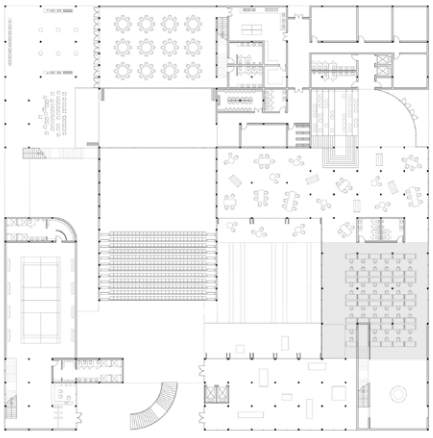


[Key Plan]
Exhibition room 2

[Rendering 3]
Study room 1

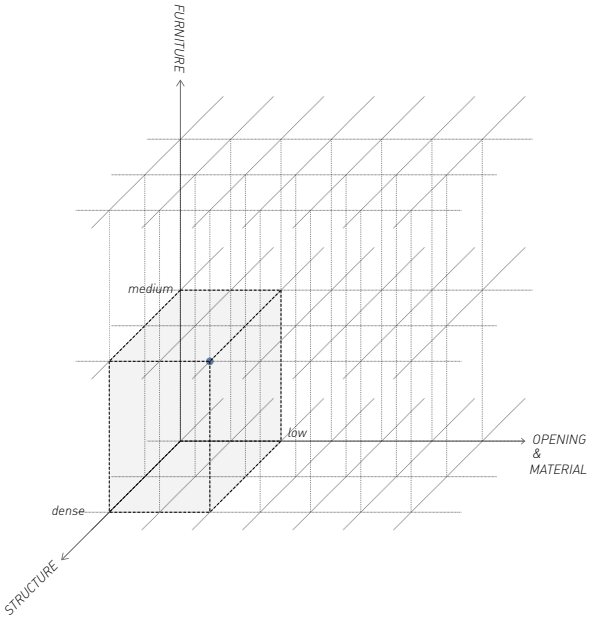


[Density Diagram]
Study room 1

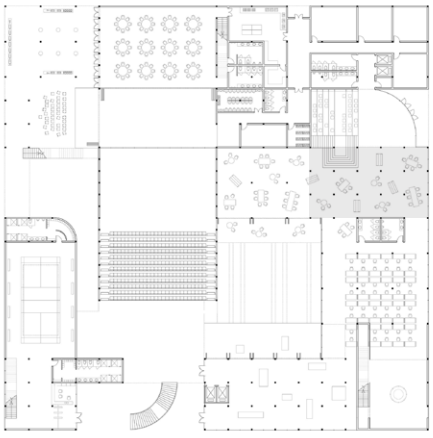


[Key Plan]
Study room 1

[Rendering 4]
Study room 2

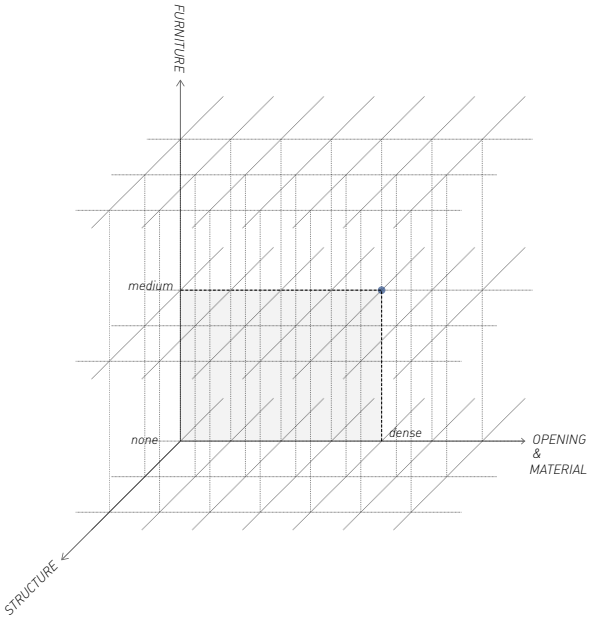


[Density Diagram]
Study room 2

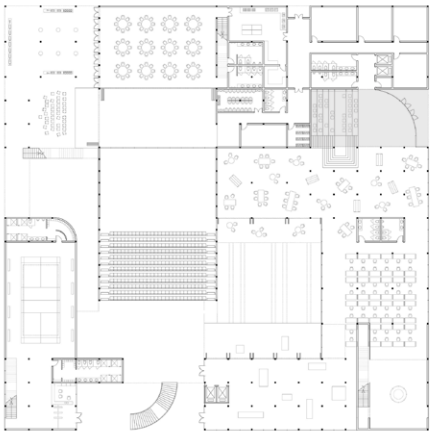


[Key Plan]
Study room 2

[Rendering 5]
Entrance lobby

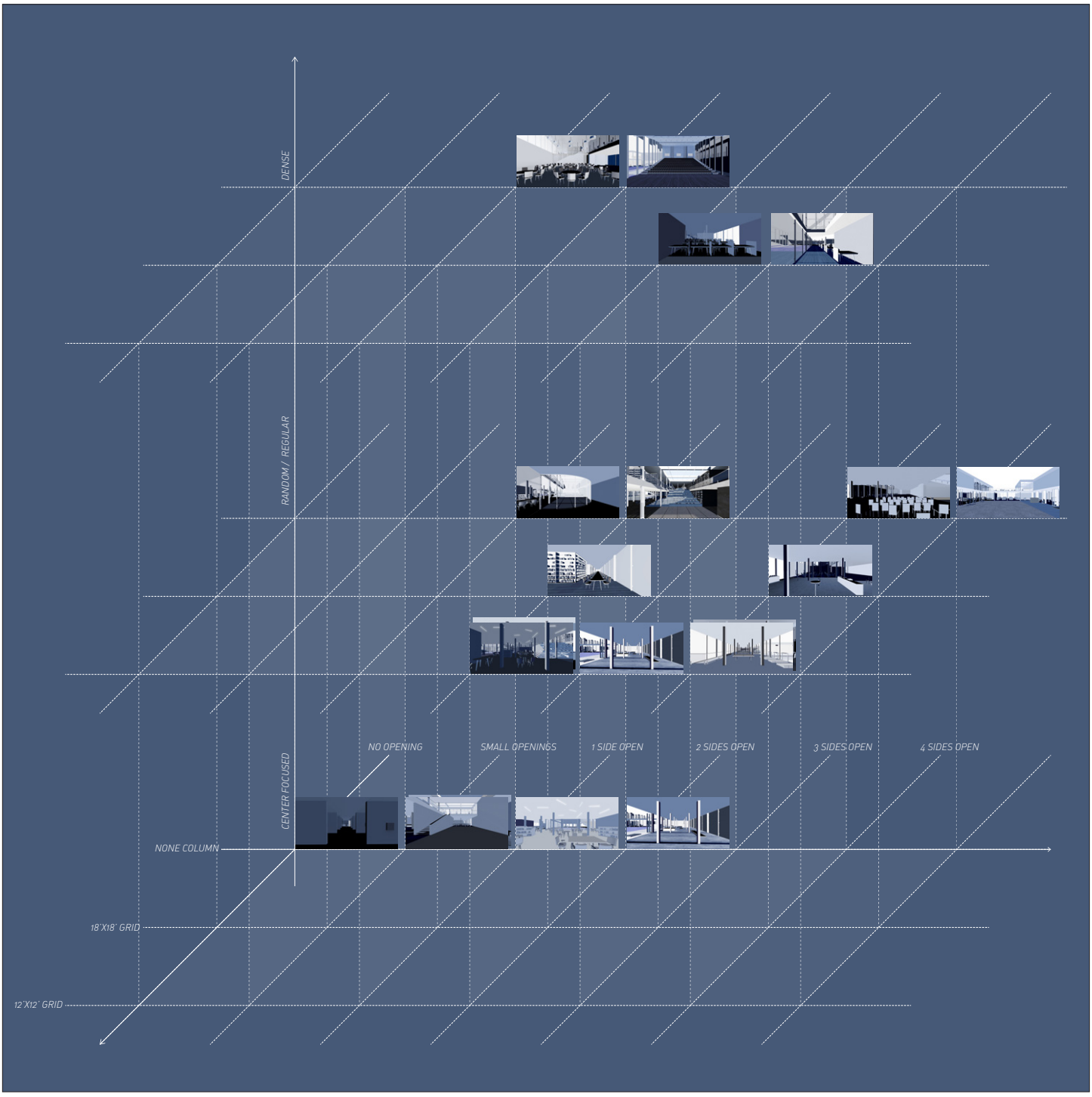


[Density Diagram]
Entrance lobby

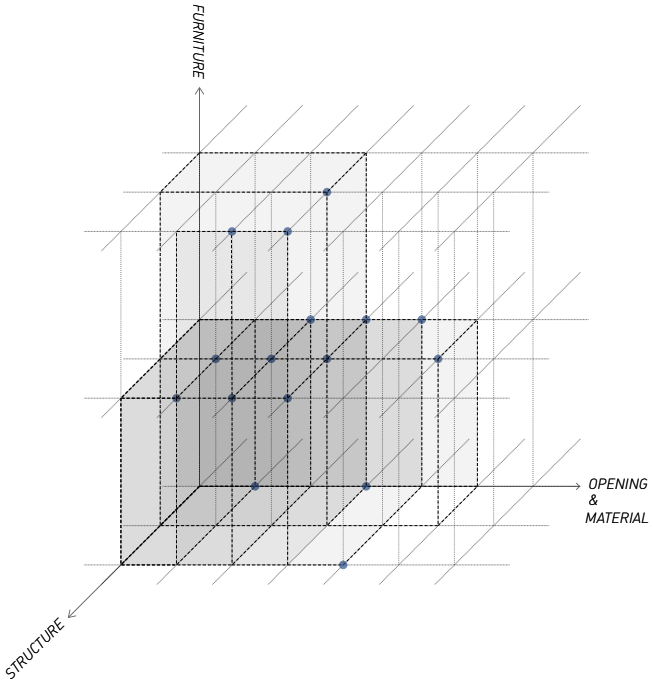


[Key Plan]
Entrance lobby

[Render Matrix]



[Density Matrix]



[Diagram]
The rhythm of density changes as people moves from one dot to another

RICE STUDENT CENTER:

AN EVER-CHANGING EXPERIENCE

The Rice Student Center tackles the issue of population diversity and individual differences by increasing spatial specificity of architecture through the methodology of dynamic density. The ultimate purpose of this project is to design a building that every occupant can find his or her preferable space.

Different people react to the same density differently and the same person reacts to different densities differently. The methodology of dynamic densities ensures the broad spectrum of diversified spatial qualities that accommodates to various needs. The rhythm of the building and spatial experiences keep changing as one circulates through the building.

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